THE UNIVERSITY OF ALBERTA

THE RELATIONSHIP OF WEIGHT DISTRIBUTION AND CHARGING TIME FOR FOOTBALL LINEMEN

A THESIS

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APPROVAL SHEET

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "The Relationship of Weight Distribution and Charging Time for Football Linemen", submitted by Dennis M. Kadatz in partial fulfilment of the requirements for the degree of Master of Arts.

ABSTRACT

The purpose of this study was to determine whether the charging RT and MT and pulling RT and MT of football linemen would be affected by three different weight distributions in their football stances.

Eighteen university and junior football players served as subjects. Each subject performed ten trials for RT and MT for thirty-six inches at: (1) his own weight distribution, (2) five percent of his body weight forward, (3) twenty percent of his body weight forward, and (4) thirty-five percent of his body weight forward for each of: (1) forward charging, (2) pulling to the left, and (3) pulling to the right.

The last six trials of the three prescribed weight distributions were used in the statistical analysis. The odd-even reliability coefficients for reaction time and movement time were $r = +0.832$ and $r = +0.981$ respectively, both of which were significant at the 0.01 level of confidence.

On the basis of statistical analysis the following conclusions appear to be justified at the 0.05 level of confidence:

1. Forward RT was significantly faster with the thirty-five percent and the twenty percent body weight forward distributions than with the five percent distribution. The thirty-five percent

stance was also significantly faster than the twenty percent stance for forward RT.

2. Left RT was significantly faster with the five percent distribution than with the thirty-five percent distribution. The twenty percent distribution was also significantly faster than the thirty-five percent distribution for left RT.

3. Right RT was significantly faster with the five percent distribution than with the thirty-five percent stance.

4. Forward MT was significantly faster with the thirty-five percent distribution than with the five percent distribution.

5. Left MT and right MT were not significantly different for any of the three weight distributions used in the study.

6. The only significant correlation between RT and MT was for forward charging with the five percent distribution ($r = -0.507$).

7. Right RT and left RT correlated significantly for all weight distributions at the 0.01 level of confidence while other directional correlations for RT and MT were not as consistent although some did reach significance.

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STATEMENT OF THE PROBLEM

Introduction. One of the basic phases of the game of football is the charge of the linemen. There are many factors which may contribute to the success of a football lineman, but the ability to charge quickly has always been considered to be an important aspect of line play.

Many coaches have been successful with a variety of football lineman's stances. A point of controversy, however, is the distribution of body weight while in the lineman's stance.

In the 1940's coaches like Bierman (1) and Caldwell (2) who used the single wing offense, taught their linemen to put a very little amount of weight forward on their hand or hands. Bierman recommends (1:21), "The player's balance is such that the weight or pressure on the fingers equals approximately five pounds." Caldwell adds (2:43), "Stance . . . with a little weight on the knuckles." In single wing football, linemen did very little straight ahead blocking and the coaches believed that in order to pull out of the line efficiently for end runs, only a little weight should be placed on the hand.

With the advent of split-T football teams in the late 1940's and early

1950's, linemen were taught to put a lot of weight forward in order to execute the quick, straight ahead block. Wilkinson, one of the leading exponents of split-T football, says (3:25), "We can best describe the correct position by saying that the hand should support body weight equal to that carried by the feet." Tatum and Giese, other experts in split-T football, claim (4:216), "Enough weight should be placed on the right hand, if the right foot is back, so that a slight 'rock back' is required to remove the hand from the turf."

More recently many coaches have stressed multiple offense. Consequently a lineman now has to be able to both pull laterally and charge straight ahead. Munn, author of the book Michigan State Multiple Offense, says (5:37), "There should be little or no weight on their hands."

Need for the study. The opinions of coaches regarding weight distribution for the football lineman's stance vary considerably. Until the present all beliefs are based on personal opinion. Aspects so important to the lineman such as the charge and pulling, should be based on scientific investigation.

Statement of the problem. The purpose of this study is to determine if various percentages of gross body weight placed on the hand in a football lineman's stance will affect reaction time and movement time over a distance of thirty-six inches. This study

should assist in providing scientific information pertinent to the following issues:

1. Do various weight distributions affect linemen's forward and lateral reaction time?

2. Do various weight distributions affect linemen's forward and lateral movement time?

Sub-problems. This study is concerned with the following subsidiary problems:

1. To determine if there is a relationship between reaction time and movement time for both charging forward and pulling laterally at each weight distribution.

2. To determine if there is a relationship between charging time and pulling time at each weight distribution.

Null hypothesis. In the present study, the null hypothesis accepts there is no significant difference in reaction time and movement time as a result of three different weight distributions in a football lineman's stance. (H_o: $\mu_1 = \mu_2 = \mu_3$).

Limitations of the study. The results and conclusions drawn from this study are limited by the following factors:

1. The number of subjects (N=18) used in the study.

2. The type of subjects (University of Alberta, Edmonton and Edmonton Huskie Junior football linemen) used in the study.

3. The methods and instruments used in the study.

4. The magnitude of experimental error by the investigator.

5. The statistical procedures used to analyze the data in the study.

6. The movement time is limited to a distance of thirty-six inches, which is the distance required between offensive and defensive linemen in Canadian football.

7. Only three weight distributions are compared, five percent, twenty percent, and thirty-five percent of the subjects total body weight placed on the hand.

8. The subject's three point football stance.

Definition of terms

Weight distribution or weight forward. The desired percentage of the subject's total body weight is placed on the subject's hand while the subject is in a three point football stance. The weight forward is calculated to the nearest whole pound and a variation of ± two pounds is allowed during testing.

Football lineman's stance. A three point (two feet and one hand) stance, which is assumed by football players playing on the line of scrimmage prior to charging forward or pulling laterally.

Charging time. The time, to the nearest one-hundredth of a second, required by the subjects to move forward from a stationary start through a horizontal distance of thirty-six inches, after an

auditory stimulus is given. This time is in fact total time (TT) made up of the sum of reaction time (RT) and movement time (MT).

Pulling time. The time, to the nearest one-hundredth of a second, required by the subjects to move laterally from a stationary start through a horizontal distance of thirty-six inches, after an auditory stimulus is given. This time is in fact total time (TT) made up of the sum of reaction time (RT) and movement time (MT).

Reaction time (RT). The time interval between the auditory stimulus and the initiation of movement by the subject's helmet.

Movement time (MT). The time interval between the initiation of movement and the contact of the subject's helmet with the target which is thirty-six inches away.

Fore-period. The time interval between the verbal preparatory stimulus and the buzzer stimulus to initiate overt action. This period will vary randomly from two to five seconds.

Auditory stimulus. The starting signal for the subjects, which will be given by a buzzer.

Preparatory stimulus. This is a verbal "get ready" given to the subjects by the investigator.

Off-side. The initiation of movement by the subject before the occurrence of the auditory stimulus.

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CHAPTER II

REVIEW OF THE LITERATURE

Introduction. Little has been done to determine a superior stance with respect to reaction time and movement time, and even less has been done on the effect that weight distribution might have on reaction time and movement time. A study which quantitatively measures the effect of weight distribution on charging time and pulling time could not be found in the literature. One study by Fitch (1) did, however, compare two stances as having the "weight forward" or the "weight back" with respect to charging time and pulling time.

The material of this chapter is organized according to three major areas: (1) references regarding linemen's stances, (2) football reaction time and movement time studies, and (3) related reaction time and movement time studies.

References regarding linemen's stances. Most authors of books dealing with the split T offense recommended that a lot of weight should be placed on the hand. These experts believe it is necessary in order to charge straight ahead with greatest speed.

Wilkinson says (2:27):

> The stance we use would be unsuitable if the linemen had to

move in a variety of directions as they do in most types of offense. However, in our attack the only movement the linemen must make effectively is straight ahead. We are not concerned with our ability to move laterally or to pull out of the line and lead plays. We want to be able to move forward with a maximum speed.

Consequently Wilkinson recommends (2:23-25):

> Hand position. In order to move straight ahead with the greatest possible facility our linemen place considerable weight on the supporting hand.
>
> We can best describe the correct position by saying that the hand should support body weight equal to that carried by the feet.

Jones recommends (3:30):

> The weight placed on the hand should be equal to the weight placed on the feet.
>
> The main difference between this stance used by split T linemen and the stance used by linemen for other offensive formations is the hand position on the ground and the amount of weight placed on it. When a lineman is required to pull out of the line to lead interference, to trap, and for pass protection, the hand on the ground is not placed as far out in front of the shoulder and little or no weight is placed on the hand.

Tatum and Giese recommend (4:195):

> We ask our linemen to assume a slightly staggered stance with their feet approximately toe to instep. The feet are spread to a comfortable width depending upon the individual's body build. Both feet should be pointed straight ahead and the weight placed on the balls of the feet. So long as trap blocking and cross blocking are not an integral part of the Split "T" offensive scheme, considerable weight may be placed upon the hand in contact with the ground. This will result in enough weight forward so that a "rock-back" is required to remove the hand from the turf.

Dodd recommends (5:60-61):

The following procedure is employed to assume a parallel stance.

1. From a standing position, place the feet parallel and as wide as the shoulders.
2. Relax the body, letting the knees bend forward with the buttocks dropping to the squatting position.
3. Extend the right hand and arm to the ground in front of the right knee, the left arm resting on the adjacent knee.
4. Lean forward upon the balls of the feet, lifting the buttocks to the level of the shoulders.
5. Shift body weight slightly forward. A minimum of 51 per cent of the weight should be forward on the extended arm.

Mather recommends (6:71):

> The weight should be on the forward foot and the fingers. The weight on the fingers should be sufficient to whiten the knuckles. Very little weight on rear foot. Both heels off ground.

With reference to weight distribution, Holgate (7:20-21) specifies that the individual place one-third of his weight over his hand and two-thirds over the balls of his feet, but he concedes that this distribution will vary with the offense employed.

The coaches who believe in multiple offense or winged T offense are convinced that in order for a lineman to pull out of the line efficiently he must put very little weight forward in his stance.

Evashevski and Nelson, the strongest promoters of the winged T, recommend (8:81):

> The first fundamental necessary to effective blocking is the base of operations. The stance of the internal linemen, the centre and the ends, has to be one that will allow

movement in all directions. Basically, all the seven are the same. This is necessary, because all the linemen have pulling assignments and the weight cannot be committed forward. Therefore, the stance must be a balanced one. The stance used is contrary to that used by T formation teams and is the best indication, among many, that this offense is about 80 percent single wing in concept and 10 percent "T" formation.

The hand touches the ground with either the fingers or knuckles but supporting no weight.

Bierman recommends (9:21):

> Three point stance . . . only one hand on the ground.
>
> To go into this stance, the player stands with his feet spread from 18 to 24 inches apart, toes turned outward at an angle of approximately 15 degrees, and the toe of one foot dropped back on a line with the instep of the other foot. The player now goes into a full squatting position, the knees spreading out as he comes down so that the distance between the knees . . . is approximately the same as that between the feet . . . The player's balance is such that the weight or pressure on his fingers equals approximately five pounds.

Bible recommends (10:10):

> The hand on the ground is a balancing agent, rather than a weight supporter . . . At the "get set" signal the lineman shifts his weight forward again and raises his hips, but still keeps them below the level of the shoulders . . . . Weight is distributed on the balls of both feet.

Crisler recommends (11:23):

> The weight should be largely on the inside of the balls of the feet, with the toes pointing out and heels in, and with the hand supporting just enough to give balance.

Munn recommends (12:37):

> Their "tails" should be up with their backs on a horizontal plane so that they may move in any direction. Their feet should not be any wider apart than about the width of their shoulders. There should be little or no weight on the hands.

Caldwell recommends (13:42-43):

> He should ease down from the hips, back straight, eyes ahead, putting down the hand on the same side as the back foot. It should be done naturally, without reaching and with a little weight on the knuckles.

Devine and Onofrio recommend (14:42):

> There should be very little weight forward on the hand. This is important because of the pulling linemen who must be able to move laterally fast and the necessity of the other linemen to step down fast for the inside shoulder block or cut off block. If too much weight is forward the linemen will be hampered in their lateral movement.

Daugherty and Wilson (15:7-9) recommend placing the supporting arm directly in line with the back foot and knee. They state no favorite distribution of weight, but instead describe the three most popular positions: (1) a great deal of weight supported on the hand, (2) little or no weight on the hand, or (3) moderate weight on the hand.

Lude claims (16:28):

> We want a stance which will allow great manoeuverability, and will permit the linemen to move forward, right, and left.

He goes on to describe one of his teaching points regarding the stance as: "Weight should be evenly distributed on the balls of the feet, with little or no weight on the hand."

Football reaction time and movement time studies. Fitch (1) is the only experimenter, to the writer's knowledge, who has studied the effect of weight distribution on the speed of the football charge.

Fitch used two weight distributions, describing one as weight forward and the other as weight back. These are his definitions (1:7):

> Weight Forward. The buttocks are parallel with the shoulders and the shoulders are at right angles to the arm or arms which touch the ground. The subject's mass is supported equally by the arms to the ground and the legs.
>
> Weight Back. The buttocks are below the subject's shoulders and the shoulders are not at right angles with the arm or arms that touch the ground. The subject's mass or centre of gravity is toward the legs and more of the mass is supported by the legs than by the arms.

These two weight distributions were used for three different stances: (1) three point with parallel feet, (2) three point with one foot back, and (3) four point with parallel feet. This made a total of six different stances. Fitch used 120 freshmen students from the required program at Indiana University as subjects. He divided them randomly into six groups of twenty each. Each group was then instructed for six periods of forty-five minutes each. Testing was done in shorts and football shoes on a dirt floor. Subjects were allowed two warm-up trials and then the best of three was used in the statistical treatment. Each subject reacted straight ahead, ninety degrees to the right, ninety degrees to the left, forty-five degrees to the right, forty-five degrees to the left and straight back . Two belts of different lengths were used to measure movement time over a distance of fifty-nine inches. The subjects merely moved as

quickly as possible on their own initiative through the required distance. Fitch arrived at the following conclusions (1:85):

> 1. The weight forward body position was superior to the weight back position for straight ahead and 45 degrees block to the right in terms of starting speed.
>
> 2. The weight forward position was equally effective as the weight back position in 90 degrees to the right, 90 degrees to the left, 45 degrees to the left and pass blocking.
>
> 3. The stances used in this study equally affected the manoeuvers tested.
>
> 4. Starting speeds on the blocking manoeuvers were affected equally by the type of body position under any one of the three stances.
>
> 5. Starting speeds on all the blocking manoeuvers were affected equally by the three stances under any one of the two body positions.

Miles (17:5), at Stanford University, pioneered the study of measuring the reaction time of the football charge movement. He used a multiple chronoscope to record charging time by placing seven players on a line with the top of their heads directly in front of a vertical trigger. The charging time was measured by the subjects responding to an auditory stimulus and charging forward against rods placed approximately four inches in front of their heads. Miles found that the football charge, when it occurred as a response to a signal which could not be anticipated, required about 0.4 seconds as an average. The average time of eighty-seven varsity football

players tested was 0.389 seconds with the first team members averaging 0.353 seconds. No statistical significance of differences by position was reported. Miles also reported a test-retest reliability coefficient of only $r = +0.36 \pm .08$.

Miles and Groves (18:14) followed up this earlier study when they studied the effect of signal variation on the reaction time of the football charge. They utilized the same measuring device as was used in the earlier study and found that reaction to an anticipatory auditory signal was much faster (0.126 seconds) compared to the non-anticipatory auditory signal (0.426 seconds).

Rosenfield (19) conducted a study measuring both reaction time and force of the football charge. He used fifty-five members of the University of Kansas freshman football team as subjects. Each subject responded to a bell stimulus by charging twelve inches to record total time and force of the charge against a padded mechanism. He concluded that there was no significant relationship between the force exerted in the football charge and the speed of the charge ($r = +0.09$). A significant correlation existed between the force exerted and the body weight of the individual ($r = +0.51$). He found no significant relationship between the weight of the individual and the speed of the charge ($r = -0.08$).

Elbel, Wilson and French (20:295) added to Rosenfield's study

by conducting a similar study of the reaction time and force of the football charge with several exceptions. They used varsity members of the University of Kansas football team and the data were obtained by having subjects respond to a vocal stimulus and charge a distance of thirty-six inches in comparison with the twelve inches used by Rosenfield. The comparative results of both studies are presented in Table I.

TABLE I

CORRELATION BETWEEN SPEED AND FORCE, FORCE AND WEIGHT, AND WEIGHT AND SPEED OF THE FOOTBALL CHARGE

	Rosenfield (19)			Elbel, Wilson, French (20)		
Activity	N	Mean	r	N	Mean	r
Speed	55	.5436		45	.5340	
Force	55	262.6		45	266.75	
Speed and Force	55		+0.09	45		+0.06
Force and Weight	55		+0.51*	45		+0.30**
Weight and Speed	55		-0.08	45		-0.51*

* Significant at the one percent level of confidence.
** Significant at the five percent level of confidence.

Manolis (21:170) studied football charging time of thirty-one members of the University of California football team and its relationship to a player's rating scale of blocking ability by three coaches. The subjects responded to a buzzer signal by charging through a target which was struck by the head twelve inches away.

Inter-judge rating correlations ranged from $r = +0.881$ to $r = +0.994$. The response times had a reliability coefficient of $r = +0.970$. He found no statistically significant differences in charging time by position on the team. Individual charging speed did not relate significantly with the rating of the coaches.

Thompson, Nagle, and Dobias (22:222) studied football starting signals and movement times of forty high school and forty-three college football players. They found that rhythmical signal calling resulted in faster movement times than non-rhythmical word digit and non-rhythmical color signals. The difference was statistically significant at the one percent level of confidence. The subjects were timed for a distance of eighteen inches. Reliability coefficients for the rhythmical signals was $r = +0.71$ and for the non-rhythmical signals was only $r = +0.52$ when seven college players were retested.

Owens (23:66) attempted to determine the effect of the front-to-rear lateral variations in foot spacings and variations in hand-to-toe anterior-posterior spacing on movement time and force of charge (shoulder impact) at the end of the movement through a distance of thirty-six inches. He also investigated the effect of rhythmical and non-rhythmical count in the starting signal on the reaction time, movement time and force of charge. Forty different types of parallel and staggered stances were used in various

combinations of hand and foot spacing. Owens concluded from his data that (23:75):

1. The differences in the forces obtained from the forty varied stances were not significant at the five percent level of confidence (F= 1.216).

2. Neither rhythmical nor non-rhythmical preparatory and starting signals produced differences in the forces of shoulder impact that were significant (F= 1.377).

3. The interaction of stance and rhythm did not produce a significant difference in the force of shoulder impact measurements (F= 0.052).

4. The differences in movement time measurements, obtained from forty varied stances, were significant at the one percent level of confidence (F=12.31).

5. Neither rhythmical nor non-rhythmical preparatory and starting signals produced differences in the speed of movement measurements that were significant (F= 0.375).

6. The interaction of stance and rhythm produced significant differences in the speed of movement measurements (F= 1.81).

7. The coefficient of correlation between force of the shoulder impact and movement time per stance was -0.95. (This high negative correlation is due to the fact that a lower numerical score in a timed event represents a better performance).

8. The coefficient of correlation between force of shoulder impact and weight per individual was .73.

9. The coefficient of correlation between reaction time and movement time per individual was .075.

10. The coefficient of correlation between anticipatory time and movement time per individual was .134.

11. The coefficient of correlation betwen anticipatory time and reaction time per individual was .342.

12. The use of rhythmical count in giving the preparatory and starting signals resulted in more off-sides.

13. The length of legs affects optimum foot and hand spacing when force of shoulder impact is the determining factor.

14. The length of legs did not seem to affect optimum hand and foot spacing when speed of movement is the determining factor.

Holtz (24) did a study with fifty-three college football players at the State University of Iowa. Holtz compared the two and three point stances in running left, right and straight ahead in relation to speed. The player had ten attempts at each skill which involved moving on the count (count resulted in the ball being lifted which started a clock) over a distance of seven yards and stopping the clock. The mean differences in favor of the three point stance were significant at the .001 level of confidence.

Harper (25), subjected football players at the University of California, Los Angeles, to a circuit training program three times a week for six weeks. The experimenter found the twelve experimental subjects were not significantly better than twelve control subjects in speed for twenty-five yards.

Meadows (26) studied the effect of isometric and isotonic training programs upon the speed of the offensive football charge in eighty-

four freshmen and varsity football players at St. Cloud State College in Minnesota. The subjects participated in a ten week training period. Meadows concluded the following (26:93):

> In the comparison between groups on speed of the offensive football charge, the isotonic group as compared to the control group and the isometric group as compared to the control group revealed significant differences at the one percent level. However, in the comparison between the two experimental groups, there was no significant difference.

Related Studies. Brace (27:372) devised an eight item physical performance test and related the results to a five factor criteria in order to predict football playing ability. The eight item test of physical performance consisted of the forward pass at a target, fifty yard dash carrying a football, forward pass for distance, pull out, blocking power speed, punting, dodge and run, and charging. Charging power was measured by a back and leg dynamometer attached by a harness and fastened to the goal post. The other data obtained consisted of the number of quarters played previously, the number of letters earned in high school, the number of games played in high school, players' average rating of playing ability of each other, and average of three coaches' ratings of playing ability of each player.

Some of the conclusions reached were as follows:(27:372):

1. The physical performance tests did not correlate

closely with each other and were, therefore, considered unrelated traits. The highest correlation was found to exist between the pass at a target and the punt for distance (+0.48) and between the 50 yard dash and the dodge and run (+0.50).

2. The best single test was found to be the 50 yard dash in terms of achievement scores.

3. A substantial correlation (+0.48) existed between achievement scores of players and the player's opinion of each other's ability.

Wilhelm (28) made a study of the characteristics which differentiate a successful football player and an unsuccessful player. He used a four battery test comprising physical performance, strength items, body structure, and mental traits. He related these items to the coaches' ratings of individual players. The following traits showed statistically significant differences (p=.05) in favor of successful football players: right grip, left grip, arm push, arm pull, back lift, leg lift, total strength, arm girth, speed and agility. When he correlated the significant test items with the criterion, it was revealed that back lift, calf girth and speed were the best items for differentiation between successful and unsuccessful football candidates. He proposed the following Football Aptitude Index: +.5864 (back lift)+.2687 (calf girth)+.5371 (speed).

Keller (29:146) studied the relationship between quickness of body movement and athletic success of 359 athletes and 277 non-athletes. Some of Keller's conclusions were as follows (29:146):

1. There was positive relationship between the ability to move the body quickly and success in athletic activities.

2. The requirement in quickness of bodily movement was not the same for all sports. A person with relatively slow body reaction time had a better chance at attaining success in the more individual activities such as gymnastics, wrestling or swimming than in those sports in which he was required to react to rapidly changing conditions and to the movement of several team-mates and opponents, such as was found in basketball, baseball, football and others.

These three studies (27, 28, 29) all demonstrate that speed is considered to be an important aspect of the good football player.

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CHAPTER III

METHODS AND PROCEDURE

Description of the Apparatus. The apparatus was designed to measure total body reaction time and movement time for a distance of thirty-six inches (Figure 1). The basic components of the apparatus were: (1) dexion framework, (2) two chronoscopes, (3) two microswitches, (4) two targets on hinges, (5) buzzer apparatus, (6) a pressure pad and meter, and (7) a recorder.

The dexion framework was constructed to allow two twelve inch by eighteen inch targets to be hung on hinges thirty-six inches apart at a height of forty-eight inches. The two microswitches were fitted to the hinge part of the targets so they would open if the targets were hit and shifted from their vertical alignment.

The pressure pad and meter were positioned just below the front target to enable the subject to assume his football stance and at the same time see how much weight he was placing on his hand. The recorder gave the experimenter a permanent record of the amount of weight that was placed on the hand (Figure 2).

The buzzer apparatus served as the stimulus for the subject and started both chronoscopes (Figure 3).

Movement of the targets caused the opening of the microswitches and the stopping of the chronoscopes.

Functioning of the Apparatus. The subject assumed the three point football stance placing his hand on the pressure pad with the desired amount of weight and the helmet in contact with the front target (Figure 4). The amount of weight placed on the pressure pad was seen by the subject on the meter and recorded permanently by the experimenter.

When the subject assumed the ready position the experimenter gave the verbal preparatory stimulus of "Get ready". Following a random fore-period the buzzer stimulus was initiated. This started both chronoscopes. The subject's initial movement of the front target stopped one chronoscope, this being recorded as the subject's reaction time. After the subject moved through a horizontal distance of thirty-six inches, as fast as possible, he hit the rear target, stopping the second chronoscope. This was recorded as the subject's total charging time. The charging time minus the reaction time resulted in movement time.

In order to facilitate the measurement of pulling time, the subject assumed the stance with the side of the helmet in contact with the front target. On the starting signal, the subject turned ninety degrees and moved as fast as possible through the rear target.

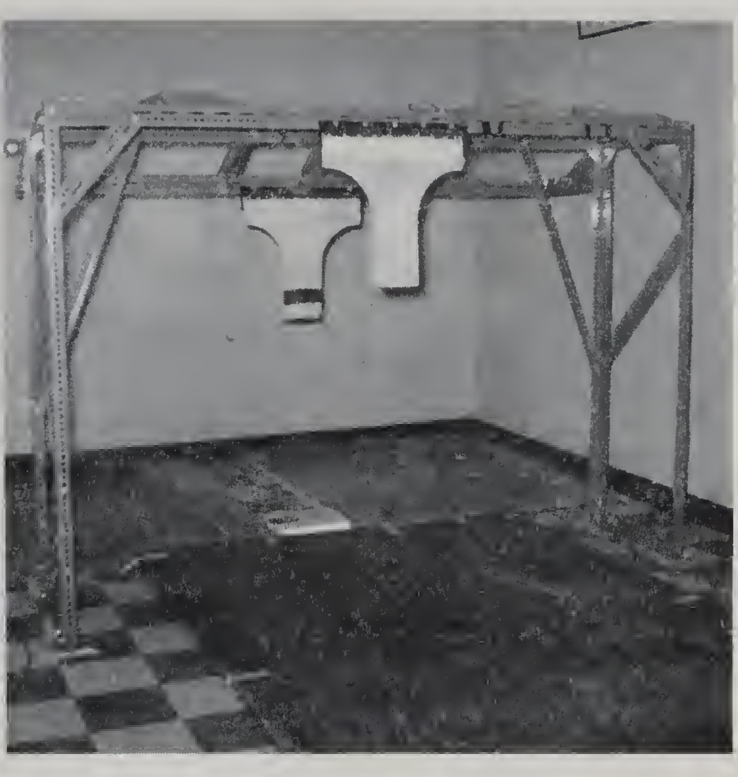

FIGURE 1

THE RT AND MT TESTING APPARATUS

FIGURE 2

THE BRUSH RECORDER

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[illegible]

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[illegible]

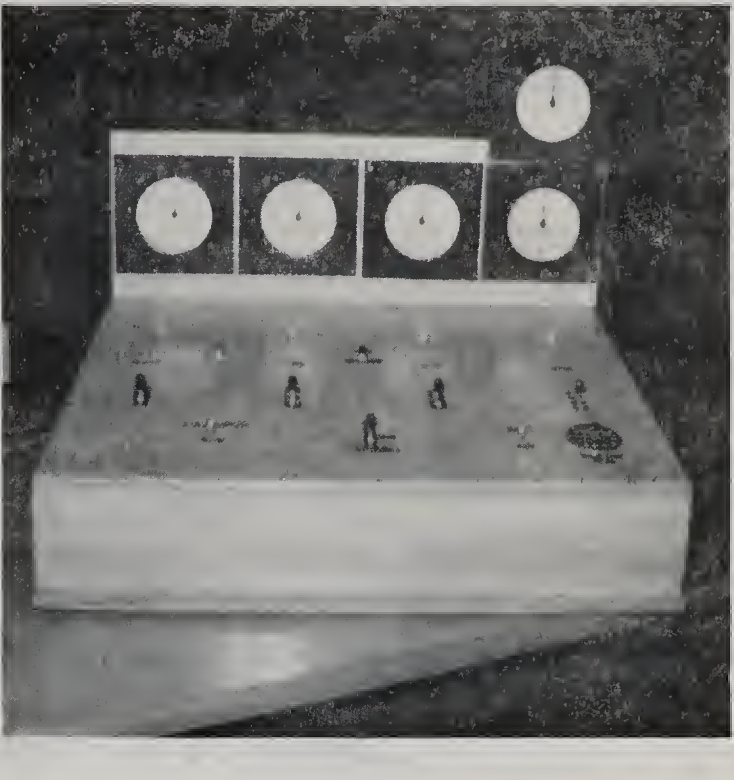

FIGURE 3
THE CONTROL PANEL WITH CHRONOSCOPES

FIGURE 4
A SUBJECT IN POSITION TO PULL TO HIS LEFT

[illegible]

[illegible]

Selection of the subjects. The eighteen volunteer subjects were all members of either the 1963 University of Alberta (Edmonton) Golden Bear Football Team or the 1963 Edmonton Huskie Junior Football Team. All subjects were linemen who were proficient in the charging and pulling technique of line play in football.

Experimental design. All testing was done in the University of Alberta, Edmonton, physical education building. The subjects reported in gymnasium costume, running shoes and a fitted football helmet. All subjects participated in a five minute light calisthenic warm-up (Appendix B) prior to all testing.

On the first day all relevant data regarding the subjects were gathered. This included: (1) weight in pounds, (2) height in inches, (3) age in years, (4) football experience in years and (5) the determination of preferred arm and leg.

On the first day, the purpose of the study, the equipment and the procedure were all explained to the subjects. Appendix C outlines testing instructions. Each subject performed ten practice trials at each of: (1) charging forward, (2) pulling to the left and (3) pulling to the right using the amount of weight forward that the players usually used. Recordings of these times and weights were made, but were not made known to the subjects.

On subsequent days, ten measurements were made for each of:

(1) charging time, (2) pulling to the left and (3) pulling to the right for each subject at each of five percent, twenty percent and thirty-five percent of total body weight forward. Each subject was randomly assigned to a testing order (Appendix D). Each subject performed at only one weight distribution on any one day. Consequently, each subject reacted forward ten times, to the right ten times, and to the left ten times during any one testing session. One measurement was taken every thirty seconds and a five minute rest after each set of ten measurements was allowed in order to avoid fatigue. Any trial (s) in which the subject went off-side was not included in the data.

As an example, a two hundred pound lineman was asked to put five percent (5/100 x 200) or ten pounds, twenty percent (20/100 x 200) or forty pounds and thirty-five percent (35/100 x 200) or seventy pounds on the hand as the three different weight distributions in the stance. A variation of ± two pounds was permitted. If the recorder showed a greater deviation from the desired weight that trial was not used in the statistical treatment. In the previous example, the subject reacted and moved thirty-six inches forward ten times, to the right ten times and to the left ten times with ten plus or minus two pounds forward. This was also repeated with forty plus or minus two pounds forward and with

seventy plus or minus two pounds forward, with a total of ninety measurements for each of the eighteen subjects.

Statistical treatment. The data in this experiment were divided into six categories:

1. Forward reaction time
2. Left reaction time
3. Right reaction time
4. Forward movement time
5. Left movement time
6. Right movement time

Each of the six categories was a separate analysis of the three weight distributions. All data were stated in whole numbers, which represented hundredths of seconds. The mean time of the last six of the ten trials was used in the statistical treatment.

CHAPTER IV

RESULTS AND DISCUSSION

Results

Subjects. The means and standard deviations of the heights, weights, ages and playing experience of the eighteen subjects may be seen in Table II.

TABLE II

MEANS AND STANDARD DEVIATIONS OF HEIGHT, WEIGHT, AGE AND EXPERIENCE OF THE SUBJECTS

Variable	Mean	S.D.
Height (inches)	71.22	0.90
Weight (pounds)	197.67	18.65
Age (years)	22.44	1.33
Experience (years)	5.56	2.02

Reliability. The Pearson Product-Moment method (1:92) was used to determine the odd - even reliability of the measurements used. The mean of the fifth, seventh and ninth trials was correlated with the mean of the sixth, eighth and tenth trials. The obtained reliability coefficients of +0.832 and +0.981 for reaction time and movement time respectively were found to be statistically significant at the 0.01 level of confidence.

TABLE III

ODD-EVEN RELIABILITY COEFFICIENTS
(N=162)

Variable	Reliability Coefficient
Reaction Time	+ 0.832
Movement Time	+ 0.981

Mean times. Table IV illustrates the overall mean times of the eighteen subjects in performing their reactions at the three different weight distributions.

TABLE IV

MEAN REACTION TIMES AND MOVEMENT TIMES
(TIME IN HUNDREDTHS OF SECONDS)

	Forward		Left		Right	
Group	RT	MT	RT	MT	RT	MT
5%	32.83	55.50	31.76	38.28	33.00	39.22
20%	30.33	53.89	31.56	38.17	34.11	36.89
35%	27.50	52.06	33.67	39.06	35.56	37.72

Forward reaction time. Analysis of variance (2:291) of the mean times for forward reaction time resulted in a F ratio which was statistically significant at the 0.01 level of confidence (Table V).

TABLE V

ANALYSIS OF VARIANCE FOR FORWARD REACTION TIME

Source of Variation	Sum of Squares	df	Mean Square	F
Weight Distribution	256.33	2	128.17	15.01*
Subjects	532.67	17	31.33	
Interaction	290.33	34	8.54	
Total	1,079.33	53		

*Statistically significant at the 0.01 level of confidence

Having determined that the means for the subjects were significantly different as the result of the three weight distributions, further analyses were carried out to ascertain which of the three means differed significantly. Duncan's New Multiple-Range test (3:107) indicated the following (Table VI):

1. Thirty-five percent was statistically significantly faster than twenty percent at the 0.05 level of confidence.

2. Thirty five percent was statistically significantly faster than five percent at the 0.05 level of confidence.

3. Twenty percent was statistically significantly faster than five percent at the 0.05 level of confidence.

TABLE VI

DUNCAN'S NEW MULTIPLE-RANGE TEST APPLIED TO THE DIFFERENCES BETWEEN K=3 TREATMENT MEANS FOR FORWARD REACTION TIME

Condition And	Means	35% 27.50	20% 30.33	5% 32.83	Least Significant R
35%	27.50	-	2.83*	5.33*	R = 1.98
20%	30.33	-	-	2.50*	R = 2.08

*Statistically significant at the 0.05 level of confidence.

Left reaction time. Analysis of variance of the mean times for left reaction time resulted in a F ratio which was statistically significant at the 0.05 level of confidence (Table VII).

TABLE VII

ANALYSIS OF VARIANCE FOR LEFT REACTION TIME

Source of Variation	Sum of Squares	df	Mean Square	F
Weight Distribution	46.45	2	23.23	3.47*
Subjects	1010.00	17	59.41	
Interaction	227.55	34	6.69	
Total	1284.00	53		

*Statistically significant at the 0.05 level of confidence.

Further analysis by Duncan's New Multiple-Range test indicated that both the five and twenty percent weight distributions resulted in statistically significantly faster left reaction times than thirty-five percent at the 0.05 level of confidence (Table VIII).

TABLE VIII

DUNCAN'S NEW MULTIPLE-RANGE TEST APPLIED TO THE DIFFERENCES BETWEEN K = 3 TREATMENT MEANS FOR LEFT REACTION TIME

Condition And	Means	20% 31.56	5% 31.78	35% 33.67	Least Significant R
20%	31.56	-	0.22	2.11*	R= 1.75
5%	31.78	-	-	1.89*	R= 1.84

*Statistically significant at the 0.05 level of confidence.

Right reaction time. Analysis of variance of the mean times for right reaction time resulted in a F ratio which was statistically significant at the 0.05 level of confidence (Table IX).

TABLE IX

ANALYSIS OF VARIANCE FOR RIGHT REACTION TIME

Source of Variation	Sum of Squares	df	Mean Square	F
Weight Distribution	59.11	2	29.56	3.43*
Subjects	748.67	17	44.04	
Interaction	293.55	34	8.63	
Total	1101.33	53		

*Statistically significant at the 0.05 level of confidence.

Duncan's New Multiple-Range test indicated that the five percent weight distribution was statistically significantly faster than thirty-five percent for right reaction time at the 0.05 level of confidence (Table X).

TABLE X

DUNCAN'S NEW MULTIPLE-RANGE TEST APPLIED TO THE DIFFERENCES BETWEEN K= 3 TREATMENT MEANS FOR RIGHT REACTION TIME

Condition and	Means	5% 33.00	20% 34.11	35% 35.56	Least Significant R
5%	33.00	-	1.11	2.56*	R = 1.99
20%	34.11	-	-	1.45	R = 2.09

*Statistically significant at the 0.05 level of confidence.

Forward movement time. Analysis of variance of the mean times for forward movement time resulted in a F ratio which was statistically significant at the 0.05 level of confidence (Table XI).

TABLE XI

ANALYSIS OF VARIANCE FOR FORWARD MOVEMENT TIME

Source of Variation	Sum of Squares	df	Mean Square	F
Weight Distribution	106.93	2	53.47	3.66*
Subjects	468.82	17	27.58	
Interaction	496.40	34	14.60	
Total	1072.15	53		

*Statistically significant at the 0.05 level of confidence.

Duncan's New Multiple-Range test indicated that mean time of the thirty-five percent weight distribution was statistically significantly faster than the five percent at the 0.05 level of confidence (Table XII).

TABLE XII

DUNCAN'S NEW MULTIPLE-RANGE TEST APPLIED TO THE DIFFERENCES BETWEEN K=3 TREATMENT MEANS FOR FORWARD MOVEMENT TIME

Condition and	Means	35% 52.06	20% 53.89	5% 55.50	Least Significant R
35%	52.06	-	1.83	3.44*	R= 2.59
20%	53.89	-	-	1.61	R= 2.72

*Statistically significant at the 0.05 level of confidence.

Left movement time. Analysis of variance of the mean times for left movement time resulted in a F ratio that was not statistically significant at the 0.05 level of confidence (Table XIII). Consequently no further analysis of this data was necessary.

TABLE XIII

ANALYSIS OF VARIANCE FOR LEFT MOVEMENT TIME

Source of Variation	Sum of Squares	df	Mean Square	F
Weight Distribution	8.44	2	4.22	1.04
Subjects	341.50	17	20.09	
Interaction	137.56	34	4.05	
Total	487.50	53		

Right movement time. Analysis of variance of the mean times for right movement time resulted in a F ratio which was statistically significant at the 0.05 level of confidence (Table XIV).

TABLE XIV

ANALYSIS OF VARIANCE FOR RIGHT MOVEMENT TIME

Source of Variation	Sum of Squares	df	Mean Square	F
Weight Distribution	126.20	2	63.10	3.32*
Subjects	817.70	17	48.10	
Interaction	646.80	34	19.02	
Total	1590.70	53		

*Statistically significant at the 0.05 level of confidence.

Duncan's New Multiple-Range test did not detect any statistically significant differences, at the 0.05 level of confidence, between two means at a time for right movement time (Table XV).

TABLE XV

DUNCAN'S NEW MULTIPLE-RANGE TEST
APPLIED TO THE DIFFERENCES BETWEEN K=3
TREATMENT MEANS FOR RIGHT MOVEMENT TIME

Condition and	Means	20% 36.89	35% 37.72	5% 39.22	Least Significant R
20%	36.89	-	0.83	2.33	R= 2.96
35%	37.72	-	-	1.50	R= 3.11

<u>Reaction time - movement time correlations</u>. Table XVI summarizes the results of the Pearson Product-Moment Correlation coefficients which were calculated between reaction time and movement time in the three directions studied. Correlations were calculated for each separate weight distribution as well as for the combination of all reactions in a particular direction. Results indicated that the following reaction time - movement time relationships were statistically significant negative correlation coefficients at the 0.05 level of confidence:

1. Reacting to the right with five percent body weight forward.

2. Reacting to the right when combining all the measurements at all three weight distributions.

TABLE XVI

REACTION TIME - MOVEMENT TIME CORRELATIONS

Direction	5% (N=18)	20% (N=18)	35% (N=18)	Combination (N=54)
Forward	-0.297	+0.041	-0.353	-0.020
Left	-0.262	-0.253	-0.203	-0.160
Right	-0.507*	-0.342	-0.121	-0.348*

*Statistically significant at the 0.05 level of confidence.

Directional correlations for reaction time. Pearson Product-Moment correlation coefficients were calculated between: (1) forward RT and left RT, (2) forward RT and right RT, and (3) left RT and right RT. Correlations were calculated for each weight distribution as well as for the combination of all measurements for all three weight distributions (Table XVII).

Results indicated the following positive correlation coefficients were statistically significant at the 0.01 level of confidence:

1. Forward RT and left RT with twenty percent of body weight forward.
2. Forward RT and left RT combining all weight distributions.

3. Left RT and right RT with five percent, twenty percent, thirty-five percent, or a combination of all three weight distributions.

The following positive correlation coefficients were statistically significant at the 0.05 level of confidence:

1. Forward RT and right RT with twenty percent weight forward.

2. Forward RT and right RT with thirty-five percent weight forward.

TABLE XVII

DIRECTIONAL CORRELATIONS FOR REACTION TIME

Directions	5% (N= 18)	20% (N= 18)	35% (N= 18)	Combination (N= 54)
Forward-Left	+0.340	+0.814**	+0.453	+0.368**
Forward-Right	+0.253	+0.505*	+0.482*	+0.229
Left - Right	+0.586**	+0.697**	+0.745**	+0.689**

**Statistically significant at the 0.01 level of confidence.
*Statistically significant at the 0.05 level of confidence.

Directional correlations for movement time. Pearson Product-Moment correlation coefficients were calculated between: (1) forward MT and left MT, (2) forward MT and right MT, and (3) left MT and right MT. Correlations were calculated for each weight distribution as well as for the combination of all measurements for all weight distributions (Table XVIII).

Results indicated the following positive correlation coefficients were statistically significant at the 0.01 level of confidence:

1. Left MT and right MT with thirty-five percent weight forward.
2. Left MT and right MT combining all weight distributions.

Other results indicated a negative correlation coefficient that was statistically significant at the 0.05 level of confidence for forward MT and right MT with five percent weight forward. Another positive correlation coefficient which was statistically significant at the 0.05 level of confidence existed between forward MT and left MT with thirty-five percent weight forward.

TABLE XVIII

DIRECTIONAL CORRELATIONS FOR MOVEMENT TIME

Directions	5% (N=18)	20% (N= 18)	35% (N= 18)	Combination (N=54)
Forward-Left	+0.007	+0.286	+0.474*	+0.187
Forward-Right	-0.536*	+0.282	+0.430	-0.124
Left - Right	+0.353	+0.359	+0.660**	+0.390**

**Statistically significant at the 0.01 level of confidence
*Statistically significant at the 0.05 level of confidence

Discussion

Reliability. In a review of related literature, many of the authors neglected to state the reliabilities of their measurements in their

studies (4, 5, 6, 7). Miles (8:5), in his study, reported a test-retest reliability coefficient of $r = +0.36 \pm 0.08$ for a reaction of four inches by football players. Thompson, Nagle, and Dobias (9:222) reported test - retest reliability coefficients from $r = +0.52$ to $r = +0.71$ for eighteen inch reactions by football players. Manolis (10:178) studied football players' reaction times and movement times for twelve inches and found their responses had an odd-even reliability coefficient of $r = +0.970$.

As in many arm movement studies (11, 12, 13), the reaction time reliability coefficient in this study was lower ($r = +0.832$) than for movement time ($r = 0.981$). Possibly the most likely explanation for this phenomenon is that the speed of reaction may be affected by psychological factors, ie., the individual's mental set or the thought processes at that particular moment. These considerations might tend to vary within the individual and have more effect on how quickly the subject reacts rather than upon the speed of movement.

Reaction time. The results indicated reaction time was significantly affected by weight distribution in a football stance. Subjects' forward reaction times were statistically significantly faster with: (1) thirty-five percent body weight forward than with twenty or five per cent body weight forward, (2) twenty percent body weight forward than with five percent body weight forward.

Pulling laterally the opposite was true, as increased weight forward seemed to slow down the subjects' reaction times. Subjects' left reaction times were significantly faster with both five and twenty percent forward than with thirty-five percent forward. Subjects' right reaction times were significantly faster with five percent forward than with thirty-five percent forward.

It was not possible to compare the results with other studies as no experiments were found in the literature reviewed which studied the effect of weight distribution on reaction time. The results did appear to agree with what authorities (14, 15, 16) claimed from personal experience.

However, reaction time of football players can be eliminated in offensive football with rhythmical anticipatory starting signals. Movement time would then appear to be the most significant aspect of the offensive line charge.

Movement time. The only statistically significant finding with respect to movement time was that the subjects were able to move forward faster with thirty-five percent forward than with five percent of their body weight forward.

This result appeared to be in agreement with Fitch (5:85) as he found the "weight forward" position to be superior to the "weight back" position for straight ahead and forty-five degrees to the right

in terms of movement time for a distance of fifty-nine inches.

Reaction time - movement time correlation. Eleven out of twelve RT - MT correlation coefficients computed were negative, but only two of the eleven were statistically significant at the 0.05 level of confidence: (1) pulling to the right with five percent forward ($r = -0.507$, $N = 18$) and (2) pulling to the right combining all measurements at all weight distributions ($r = -0.348$, $N = 54$).

Owens (17:75) reported a non-significant correlation of $r = +0.075$ between reaction time and movement time for thirty-six inches.

Lotter (18:154) found non-significant correlations of $r = -0.087$ and $r = -0.146$ for right and left legs respectively in studying the reaction time and movement time of the leg in a kicking action. In another study of the leg, Fairclough (19:27) also reported a non-significant negative correlation of $r = -0.278$. More recently, Kerr (20:83) found statistically significant positive correlations ranging from $r = +0.532$ to $r = +0.849$ between reaction time and movement time.

The results of this study appeared to follow the general pattern of all reaction time - movement time correlation studies, ie. that is no consistency. One explanation might be that the correlation between reaction time and movement time depends upon the specific task involved.

Directional correlations. Studies which correlated football players' ability to react and move in different directions could not be found in the literature by the author.

One consistent result in this study was that right reaction time did correlate significantly with left reaction time at all weight distributions. Another interesting result was that forward RT - left RT, forward RT-right RT, and left RT - right RT correlated significantly using the twenty percent weight distribution. The thirty-five percent distribution had significant correlations for forward RT - right RT and left RT - right RT.

Movement times appeared to be more specific with respect to directional correlations as only the thirty-five percent distribution resulted in a significant correlation between left MT and right MT. The thirty-five percent stance also had a significant correlation for forward MT and left MT. The twenty percent distribution had no significant correlations for movement time while the five percent distribution had a significant negative correlation for forward MT and right MT.

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CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The purpose of this study was to determine whether the charging RT and MT and pulling RT and MT of football linemen would be affected by three different weight distributions in their football stances. Reaction time - movement time correlations and directional correlations were considered as subproblems.

Eighteen university and junior football players served as subjects. One hundred twenty measurements were made on each subject using an apparatus designed to measure the RT and MT for thirty-six inches. Each subject performed ten trials for RT and MT at: (1) his own weight distribution, (2) five percent of his body weight forward, (3) twenty percent of his body weight forward and (4) thirty-five percent of his body weight forward for each of: (1) charging forward, (2) pulling to the left and (3) pulling to the right. The subjects were randomly assigned to one sequence of a balanced testing order.

Analyses of the data were made on the last six trials of the

three specified weight distributions. Computations of odd-even reliability coefficients resulted in a $r = +0.832$ for reaction time and in a $r = +0.981$ for movement time, both of which were statistically significant at the 0.01 level of confidence.

Conclusions

On the basis of statistical analysis several conclusions seemed to be justified in terms of the limitations of the study.

Reaction time. The following statements were statistically significant at the 0.05 level of confidence:

1. Thirty-five percent weight forward resulted in faster forward RT than five percent weight forward.

2. Thirty-five percent weight forward resulted in faster forward RT than twenty percent weight forward.

3. Twenty percent weight forward resulted in faster forward RT than five percent weight forward.

4. Five percent weight forward resulted in faster left RT than thirty-five percent weight forward.

5. Twenty percent weight forward resulted in faster left RT than thirty-five percent weight forward.

6. Five percent weight forward resulted in faster right RT than thirty-five percent weight forward.

Movement time. The following statements were statistically

significant at the 0.05 level of confidence:

1. Thirty-five percent weight forward resulted in faster forward MT than five percent weight forward.

2. Comparison of two weight distributions at a time, failed to result in any significant differences for left MT and for right MT.

Reaction time - movement time correlations. Only one RT - MT correlation was statistically significant at the 0.05 level of confidence. A negative correlation ($r = -0.507$) for forward charging with the five percent weight distribution was significant.

Directional correlations. The following statements were statistically significant:

1. Right RT and left RT correlated significantly (0.01 level) at each weight distribution.

2. Forward RT and left RT correlated significantly (0.01 level) for the twenty percent weight distribution.

3. Forward RT and right RT correlated significantly (0.05 level) for the twenty and thirty-five percent distributions.

4. Right MT and left MT correlated significantly (0.01 level) for the thirty-five percent weight distribution.

5. Forward MT and left MT correlated significantly (0.05 level) for the thirty-five percent distribution.

6. A significant (0.05 level) negative correlation resulted between

forward MT and right MT for the five percent weight distribution.

Recommendations

During the course of the experiment several further studies became apparent as possible means to further clarify the question of weight distribution and charging time in football. The following studies are therefore recommended:

1. The effect of weight distribution on pulling MT for a greater distance than thirty-six inches because pulling is usually done for a distance greater than thirty-six inches.

2. A greater range of weight distributions should be used in another study to determine the optimum distribution for both forward and lateral RT and MT.

3. A comparison of RT and MT using an experimentally proven distribution with the RT and MT of players using their own distribution.

4. The effect of weight distribution on the force of the football charge.

5. The effect of endurance, strength, and other physical fitness factors on RT and MT of football players.

6. The effect of playing experience on football charging RT and MT.

Answers to these problems and others like them should enable

football coaches to be more precise in teaching weight distribution in a football stance.

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APPENDICES

APPENDIX A

STATISTICAL TREATMENT

STATISTICAL TREATMENT

Reliability of the measurements. Reliability coefficients were computed by use of the Pearson Product-Moment correlation coefficient. The formula used was (1:92):

$$r = \frac{N \Sigma X Y - \Sigma X \Sigma Y}{\sqrt{[N \Sigma X^2 - (\Sigma X)^2] \; [N \Sigma Y^2 - (\Sigma Y)^2]}}$$

where X = mean of odd scores
Y = mean of even scores

Analysis of variance. An analysis of variance designed to test the significance of the difference between means obtained from correlated groups was used in this study (2:291).

Duncan's New Multiple - Range Test. Duncan's New Multiple - Range test (3:136) was used to determine if there were any statistically significant differences between two means at a time. This test was used whenever a statistically significant F ratio was found in the analysis of variance.

Correlation coefficients. Pearson's Product-Moment Correlation coefficient was used.

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APPENDIX B

WARM-UP EXERCISES

WARM-UP EXERCISES

1. Run on the Spot. Run on the spot up to a count of twenty-five lifting the feet at least six inches off the floor. Each time the left foot hits the floor counts one.
2. Sit-ups. Do five straight legged sit-ups with both hands behind the head.
3. Vertical jumps. Do two standing vertical jumps for maximum height using a two foot take-off.
4. Push-ups. Do five push-ups keeping the back as straight as possible.
5. Football charges. Do one straight ahead charge for five yards, one to the left for five yards and one to the right for five yards.

APPENDIX C

TESTING INSTRUCTIONS

TESTING INSTRUCTIONS

1. Assume your best three point football stance using _____pounds* on your hand with your helmet touching the front target.
2. You will get a verbal "Get ready" and after a short period of time varying from two to five seconds a buzzer will sound.
3. When the buzzer sounds react as quickly as possible through the rear target.
4. You will be asked to react once every 30 seconds.
5. Do your best on every trial.

*This value will depend on whether the subject is reacting with five percent, twenty percent, or thirty-five percent of his total body weight on his hand.

APPENDIX D

TESTING ORDER

TESTING ORDER

	5 PERCENT			20 PERCENT			35 PERCENT		
	Forward	Right	Left	Forward	Right	Left	Forward	Right	Left
1	1	2	3	6	4	5	8	9	7
2	1	3	2	5	4	6	9	8	7
3	3	1	2	5	6	4	7	8	9
4	2	1	3	6	5	4	7	9	8
5.	3	2	1	4	6	5	8	7	9
6	2	3	1	4	5	6	9	7	8
7	8	9	7	1	2	3	6	4	5
8	9	8	7	1	3	2	5	4	6
9	7	8	9	3	1	2	5	6	4
10	7	9	8	2	1	3	6	5	4
11	8	7	9	3	2	1	4	6	5
12	9	7	8	2	3	1	4	5	6
13	6	4	5	8	9	7	1	2	3
14	5	4	6	9	8	7	1	3	2
15	5	6	4	7	8	9	3	1	2
16	6	5	4	7	9	8	2	1	3
17	4	6	5	8	7	9	3	2	1
18	4	5	6	9	7	8	2	3	1

APPENDIX E

INDIVIDUAL SCORE SHEET

FOOTBALL STUDY SCORE SHEET

Name ______________________ Age __________ Weight __________

Playing Experience ________ Off. Position. ____________ Preferred Leg ________________

Weight ________________ Percentage Wgt. Forward ________________

Arm ________________ Testing Order ________________

	FORWARD			LEFT			RIGHT		
Trials	TT	RT	MT	TT	RT	MT	TT	RT	MT
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

APPENDIX F

RAW DATA

INFORMATION ABOUT SUBJECTS

Subject		Age (Yrs.)	Height (ins.)	Weight (lbs.)	Position	Leg	Arm	Exp.
1.	J.S.	20	75	220	E	R	R	2
2.	B.S.	23	67	192	G	R	R	8
3.	G.N.	23	70	210	G	R	R	9
4.	L.G.	20	72	162	E	R	R	5
5.	M.R.	22	73	224	T	R	R	7
6.	R.E.	24	73	186	E	R	R	7
7.	W.H.	21	71	201	G	R	R	4
8.	S.E.	22	70	192	G	R	R	6
9.	V.J.	20	66	164	G	R	R	3
10.	R.F.	22	72	190	E	R	R	4
11.	K.M.	19	73	190	E	L	R	4
12.	G.C.	22	75	204	T	R	R	4
13.	P.B.	22	69	199	G	R	R	7
14.	B.C.	22	71	169	F.B.	R	R	9
15	B.W.	21	69	204	T	R	R	6
16.	R.F.	21	76	221	E	R	R	5
17.	B.B.	22	67	206	G	L	L	7
18.	G.S.	20	73	224	T	R	R	3

SUBJECT #1

Forward

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	32	67	30	56	19	53
2	31	62	37	55	26	53
3	41	60	31	59	28	51
4	41	54	31	54	28	51
5	-	-	33	50	27	51
6	36	51	33	54	27	51
7	41	50	-	-	31	51
8	41	51	29	53	26	51
9	33	51	21	48	27	49
10	32	51	34	53	24	51

Left

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	35	38	30	41	34	41
2	47	37	31	39	32	37
3	38	37	38	39	27	40
4	32	39	32	40	31	41
5	33	38	31	41	32	37
6	29	40	28	40	33	41
7	33	39	34	40	19	40
8	32	39	35	39	30	39
9	36	40	30	32	34	41
10	33	41	31	42	36	40

Right

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	46	36	37	40	39	41
2	40	34	34	38	39	43
3	37	33	35	38	-	-
4	37	41	40	39	34	39
5	38	38	32	43	37	42
6	-	-	35	39	-	-
7	35	33	35	39	32	41
8	39	36	-	-	26	40
9	40	39	38	38	-	-
10	31	41	37	38	32	41

SUBJECT #2

Forward

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	33	55	30	49	25	45
2	31	55	29	48	28	45
3	-	-	37	54	31	47
4	29	56	22	52	30	46
5	37	57	25	52	29	43
6	31	52	34	45	27	47
7	33	52	31	46	23	47
8	31	56	36	48	31	45
9	-	-	31	47	37	48
10	39	55	28	46	25	46

Left

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	31	38	32	37	38	38
2	33	38	35	37	38	34
3	31	38	33	35	37	34
4	31	39	-	-	39	33
5	33	39	40	34	36	34
6	32	39	33	36	34	35
7	31	39	-	-	36	34
8	34	36	28	35	38	34
9	33	39	33	36	38	34
10	37	40	32	35	40	34

Right

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	37	36	37	35	-	-
2	-	-	39	37	36	37
3	-	-	30	33	35	36
4	-	-	35	33	35	36
5	34	41	41	34	-	-
6	32	42	32	33	40	35
7	30	38	31	35	37	33
8	35	40	30	35	35	36
9	29	40	35	34	35	34
10	33	38	32	34	-	-

SUBJECT #3

	Forward					
	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	23	58	25	53	-	-
2	34	57	33	53	21	52
3	33	54	27	53	21	53
4	29	58	22	51	26	51
5	30	54	26	53	20	52
6	26	53	22	52	24	54
7	32	56	29	49	23	52
8	33	61	28	52	26	50
9	26	55	-	-	22	51
10	31	54	21	52	24	51

	Left					
	5%		20%		35%	
Trials	RT	MT	RT	MT	RT	MT
1	32	44	28	39	19	44
2	20	47	32	38	19	44
3	27	40	27	41	21	42
4	29	41	22	39	19	41
5	40	37	22	39	20	42
6	26	39	25	41	22	38
7	25	39	23	37	21	40
8	-	-	24	38	20	41
9	25	40	23	37	-	-
10	30	38	27	40	29	33

	Right					
	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	30	38	28	28	27	40
2	30	30	32	29	27	38
3	27	32	40	30	27	36
4	28	31	30	31	27	36
5	29	30	32	27	28	39
6	32	29	28	31	24	37
7	34	29	33	27	-	-
8	29	30	27	30	26	37
9	32	27	27	30	30	33
10	38	32	31	28	25	40

SUBJECT #4

	Forward					
	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	45	48	32	51	28	47
2	41	51	29	50	45	50
3	48	47	30	53	33	49
4	43	48	31	54	33	50
5	44	46	-	-	30	50
6	-	-	-	-	29	53
7	45	54	27	55	-	-
8	42	52	28	54	28	49
9	42	51	31	51	26	48
10	39	49	31	52	33	50

	Left					
	5%		20%		35%	
Trials	RT	MT	RT	MT	RT	MT
1	40	38	40	43	39	39
2	-	-	42	39	41	35
3	30	39	33	35	35	40
4	33	37	38	40	37	38
5	30	41	-	-	39	34
6	32	40	39	38	42	36
7	35	39	32	38	39	40
8	38	35	32	38	36	36
9	-	-	38	35	40	39
10	38	37	30	38	40	39

	Right					
	5%		20%		35%	
Trials	RT	MT	RT	MT	RT	MT
1	31	42	35	36	-	-
2	39	41	34	37	45	39
3	31	42	31	37	42	37
4	32	41	42	35	33	40
5	43	40	37	36	44	35
6	30	44	44	34	42	38
7	38	43	37	34	52	39
8	-	-	37	32	43	33
9	33	40	37	35	50	30
10	30	44	38	36	36	40

SUBJECT #5

	Forward					
	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	37	60	31	56	30	50
2	34	60	-	-	25	50
3	30	62	33	53	29	51
4	35	56	27	54	29	48
5	39	60	28	53	30	53
6	35	57	25	55	24	50
7	37	56	28	59	29	51
8	-	-	32	52	23	51
9	32	57	34	56	24	50
10	38	67	30	53	30	49

	Left					
	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	36	42	32	38	33	44
2	24	42	34	38	30	42
3	24	40	23	41	30	40
4	24	42	33	39	29	44
5	22	41	23	40	28	41
6	23	39	26	38	25	44
7	25	39	25	40	26	45
8	22	39	25	40	25	42
9	26	37	25	40	29	42
10	23	40	26	39	24	38

	Right					
	5%		20%		35%	
Trials	RT	MT	RT	MT	RT	MT
1	-	-	43	45	31	44
2	25	44	28	42	-	-
3	28	42	24	46	29	41
4	31	42	30	44	27	43
5	25	40	26	43	29	44
6	27	43	27	40	-	-
7	28	42	30	42	25	41
8	27	39	26	45	28	42
9	27	42	26	43	28	45
10	29	39	25	43	28	44

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SUBJECT #6

	Forward					
	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	21	61	29	56	29	53
2	27	61	25	54	24	55
3	26	60	27	51	24	56
4	28	55	24	53	28	56
5	33	54	36	49	22	54
6	33	52	31	50	22	54
7	29	55	27	52	25	53
8	29	52	28	48	22	54
9	28	54	26	48	25	54
10	27	53	26	49	21	55

	Left					
	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1.	33	44	34	36	31	35
2	35	43	38	36	33	36
3	37	38	28	39	36	36
4	31	37	35	34	28	39
5	29	37	29	36	34	36
6	34	37	27	38	33	37
7	31	38	34	36	32	35
8	30	35	31	34	34	35
9	30	35	38	39	37	34
10	29	35	27	43	40	37

	Right					
	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	30	38	32	34	35	36
2	31	36	30	37	30	35
3	30	39	30	38	33	37
4	34	41	35	34	40	36
5	29	40	34	36	38	35
6	32	40	35	36	35	33
7	34	39	36	33	32	31
8	34	39	33	37	33	32
9	32	38	38	31	35	30
10	32	37	33	35	40	31

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SUBJECT #7

Forward

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	32	59	31	52	26	51
2	34	55	36	56	33	51
3	36	54	36	54	27	52
4	31	55	39	52	26	54
5	32	59	33	53	26	52
6	31	54	40	51	30	52
7	28	59	26	54	27	53
8	29	58	44	54	32	52
9	29	55	35	55	27	51
10	35	55	35	53	32	52

Left

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	35	32	42	37	39	37
2	34	33	45	32	37	37
3	31	29	46	31	32	39
4	37	33	39	30	31	40
5	32	34	41	31	49	35
6	41	31	42	34	36	34
7	33	34	47	32	37	33
8	-	-	41	32	35	33
9	35	35	38	35	30	35
10	34	32	39	35	38	31

Right

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	38	29	44	27	40	32
2	41	28	43	28	44	34
3	39	26	44	27	38	32
4	40	27	49	26	35	35
5	45	27	49	28	36	38
6	44	27	46	26	40	35
7	39	26	43	29	38	30
8	40	27	44	30	36	35
9	44	27	49	26	38	32
10	37	28	46	28	34	32

SUBJECT # 8

	Forward					
	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	26	64	32	58	31	55
2	31	66	40	63	29	55
3	-	-	26	62	-	-
4	28	59	-	-	-	-
5	27	64	31	56	27	54
6	28	62	37	51	28	53
7	26	62	29	58	31	58
8	26	63	32	57	26	55
9	24	63	26	61	22	57
10	27	61	32	56	17	62

	Left					
	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	31	43	60	42	37	42
2	28	42	29	42	31	49
3	34	38	31	46	36	45
4	31	40	33	40	37	43
5	34	42	35	42	29	47
6	37	40	34	43	32	40
7	41	40	-	-	34	41
8	36	39	30	43	34	42
9	32	40	32	43	35	44
10	36	38	36	42	36	45

	Right					
	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	31	34	37	40	-	-
2	31	38	32	38	31	47
3	32	39	35	39	39	41
4	36	39	30	43	28	41
5	32	40	34	43	40	38
6	31	40	36	41	32	42
7	28	38	40	40	34	43
8	28	40	32	40	36	42
9	30	40	38	38	35	38
10	26	40	35	39	38	39

SUBJECT #9

Forward

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	25	57	26	52	-	-
2	-	-	-	-	25	52
3	22	58	-	-	22	53
4	28	57	31	53	23	52
5	22	58	38	53	27	51
6	26	56	26	51	23	50
7	35	49	30	52	25	52
8	29	55	29	51	26	50
9	32	53	36	51	-	-
10	26	55	29	53	22	53

Left

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	25	40	30	37	25	40
2	25	39	30	38	28	40
3	31	39	24	43	26	39
4	29	34	27	40	26	39
5	-	-	27	38	27	39
6	25	39	30	39	23	37
7	28	35	25	39	21	42
8	28	36	26	39	28	41
9	25	35	28	38	23	39
10	24	36	24	37	27	38

Right

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	-	-	32	33	33	35
2	31	37	30	32	40	31
3	39	30	27	34	29	37
4	27	35	36	33	34	33
5	28	36	33	34	35	36
6	31	34	37	32	32	37
7	34	35	29	31	38	36
8	30	34	32	32	36	34
9	31	34	28	33	37	32
10	31	35	31	33	26	38

SUBJECT #10

Forward

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	36	52	22	55	27	49
2	33	54	31	53	35	49
3	31	54	40	51	29	49
4	30	52	31	52	26	47
5	31	53	30	53	33	45
6	30	53	31	52	28	49
7	35	51	28	54	32	49
8	29	54	34	47	27	47
9	32	50	30	49	30	49
10	29	51	26	51	26	47

Left

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	30	40	34	42	34	36
2	31	39	36	39	34	37
3	27	40	33	40	39	39
4	28	40	29	40	33	41
5	28	41	33	37	35	36
6	26	42	30	43	32	38
7	30	43	-	-	31	37
8	35	41	-	-	28	44
9	30	42	32	43	30	40
10	31	40	31	42	32	42

Right

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	31	38	35	39	38	37
2	40	35	40	41	44	37
3	31	35	34	37	34	40
4	34	33	26	45	35	36
5	32	36	31	39	46	32
6	31	36	40	41	34	35
7	31	35	30	38	36	33
8	32	35	33	39	35	32
9	40	37	31	39	40	32
10	36	33	30	40	35	31

SUBJECT #11

Forward

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	41	61	38	59	31	52
2	40	61	31	64	34	52
3	43	61	38	55	31	53
4	36	66	37	51	36	48
5	41	61	34	56	31	52
6	39	54	40	53	43	52
7	46	55	39	51	34	47
8	42	53	50	50	30	49
9	47	52	40	52	32	47
10	44	53	38	55	37	49

Left

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	41	42	35	42	42	43
2	39	39	43	41	46	45
3	34	40	44	41	49	36
4	34	40	37	41	50	40
5	42	43	37	43	52	40
6	39	42	37	40	39	42
7	37	40	43	36	41	39
8	33	36	47	38	38	42
9	32	36	48	36	46	44
10	33	36	-	-	46	42

Right

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	33	40	34	43	39	46
2	36	40	40	41	35	46
3	32	41	33	52	40	45
4	40	41	35	46	38	42
5	33	39	34	41	50	44
6	32	39	30	43	46	44
7	32	39	35	42	38	39
8	35	38	34	41	34	45
9	32	39	36	41	33	43
10	31	42	35	43	36	40

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
١	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٢	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٣	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٤	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٥	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٦	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٧	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٨	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٩	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
١٠	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
١	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٢	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٣	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٤	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٥	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٦	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٧	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٨	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٩	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
١٠	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
١	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٢	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٣	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٤	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٥	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٦	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٧	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٨	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
٩	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
١٠	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SUBJECT #12

Forward

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	-	-	36	54	30	50
2	32	60	24	53	33	54
3	28	59	24	56	26	53
4	27	59	27	57	30	51
5	27	62	26	53	33	48
6	26	59	25	55	33	50
7	27	58	28	52	-	-
8	33	55	28	52	32	52
9	27	62	30	54	33	51
10	28	59	25	54	35	53

Left

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	31	44	-	-	32	44
2	29	40	36	38	36	43
3	27	41	-	-	43	43
4	27	42	-	-	35	44
5	-	-	29	38	42	38
6	24	43	28	39	36	40
7	28	39	32	38	35	43
8	26	41	25	42	35	48
9	24	42	26	44	32	42
10	26	41	26	41	30	44

Right

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	29	41	25	41	38	39
2	29	42	30	39	37	36
3	32	42	29	37	36	37
4	28	40	27	38	38	41
5	26	42	32	37	31	38
6	26	42	30	35	-	-
7	31	42	26	40	43	34
8	25	43	29	38	36	35
9	27	41	26	41	38	35
10	26	41	30	37	34	35

SUBJECT #13

Forward

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	27	64	26	57	-	-
2	32	71	32	55	24	52
3	34	62	33	57	26	53
4	29	59	28	53	25	53
5	33	56	25	55	25	52
6	29	59	30	54	24	54
7	33	59	28	52	26	53
8	28	58	28	54	-	-
9	27	61	33	52	25	53
10	35	61	28	53	21	53

Left

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	33	39	31	39	32	37
2	-	-	35	41	38	35
3	-	-	30	40	31	40
4	27	39	27	39	32	39
5	28	40	26	42	35	37
6	27	39	32	41	26	38
7	30	40	29	42	43	34
8	28	41	26	39	34	37
9	-	-	28	40	33	35
10	35	42	24	42	33	35

Right

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	24	43	26	44	33	46
2	30	39	31	42	-	-
3	32	43	25	40	34	37
4	-	-	29	40	34	36
5	27	39	31	40	33	37
6	30	42	-	-	40	36
7	30	43	28	40	39	36
8	33	41	28	39	35	38
9	41	40	28	39	38	36
10	33	44	30	40	37	37

SUBJECT # 14

	Forward					
	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	36	40	35	63	-	-
2	36	38	20	61	26	61
3	41	38	-	-	33	53
4	31	40	-	-	33	56
5	33	40	24	60	30	56
6	33	40	22	60	23	59
7	-	-	18	62	18	60
8	32	40	24	61	15	61
9	39	38	23	60	24	55
10	32	39	26	59	29	55

	Left					
	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	30	39	26	41	31	39
2	31	38	27	41	37	40
3	34	38	26	40	29	39
4	30	40	28	41	26	41
5	32	42	28	41	27	40
6	30	37	25	42	31	40
7	33	38	29	42	34	41
8	33	37	32	42	31	37
9	28	39	-	-	34	40
10	33	41	23	43	35	42

	Right					
	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	28	62	33	40	33	43
2	27	66	41	41	30	41
3	28	65	33	38	35	45
4	27	66	32	39	33	38
5	-	-	33	38	35	39
6	26	64	30	40	34	38
7	26	62	44	40	32	38
7	25	66	32	41	31	38
9	31	64	31	38	32	39
10	27	65	35	38	36	40

SUBJECT #15

Forward

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	46	59	38	52	47	53
2	36	47	30	53	29	50
3	28	59	34	53	-	-
4	30	60	37	53	46	50
5	26	60	30	52	25	50
6	28	56	33	54	31	48
7	41	57	29	54	24	53
8	26	61	36	55	25	49
9	31	58	29	51	27	50
10	31	59	28	62	26	49

Left

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	36	34	41	32	40	32
2	33	36	38	34	46	34
3	32	36	34	34	37	34
4	36	36	32	34	39	31
5	37	35	-	-	36	35
6	33	35	36	34	38	34
7	34	34	39	34	46	34
8	38	34	39	37	40	33
9	32	36	35	32	42	34
10	34	36	30	35	42	35

Right

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	36	35	38	35	48	44
2	36	36	36	37	38	42
3	33	37	34	28	30	39
4	39	35	32	37	33	41
5	35	38	-	-	28	38
6	40	36	36	40	33	38
7	-	-	31	40	33	39
8	-	-	28	38	38	36
9	31	40	35	36	30	36
10	34	39	34	35	33	34

SUBJECT #16

Forward

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	33	57	26	55	26	50
2	28	56	31	55	27	52
3	26	54	29	54	25	52
4	31	54	24	56	32	50
5	29	56	20	56	27	51
6	30	62	33	53	24	50
7	32	58	32	50	30	50
8	24	57	28	50	31	49
9	30	60	25	52	27	51
10	28	58	26	54	27	49

Left

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	29	38	30	32	33	36
2	28	37	29	34	32	35
3	33	37	27	34	38	39
4	29	35	27	32	26	35
5	26	36	27	30	29	36
6	28	37	33	34	29	35
7	29	34	29	32	30	34
8	27	33	33	34	33	37
9	28	34	26	33	35	36
10	29	34	27	33	29	34

Right

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	34	39	23	36	33	43
2	32	37	26	38	40	41
3	31	35	35	39	26	40
4	31	35	25	37	34	40
5	28	35	31	37	30	43
6	32	36	25	37	32	39
7	33	35	26	38	36	38
8	38	34	26	37	36	35
9	30	34	32	37	29	37
10	26	35	25	36	36	41

SUBJECT # 17

Forward

Trial	5%		20%		35%	
	RT	MT	RT	MT	RT	MT
1	35	61	31	59	43	55
2	46	62	30	54	35	51
3	37	63	-	-	31	53
4	39	64	-	-	26	52
5	34	62	33	60	32	54
6	35	61	33	64	-	-
7	33	62	33	63	28	57
8	35	62	41	61	27	61
9	30	62	41	61	27	61
10	35	65	30	64	28	60

Left

Trial	5%		20%		35%	
	RT	MT	RT	MT	RT	MT
1	35	38	46	39	46	43
2	40	37	42	43	46	46
3	42	39	35	42	43	47
4	40	39	48	38	41	42
5	33	39	46	44	41	40
6	38	38	40	43	38	39
7	43	38	34	38	31	53
8	42	39	35	39	50	42
9	38	39	28	45	43	42
10	36	41	33	44	41	43

Right

Trial	5%		20%		35%	
	RT	MT	RT	MT	RT	MT
1	36	38	44	36	-	-
2	35	41	37	35	42	48
3	41	42	41	35	45	46
4	39	41	39	34	38	44
5	35	40	44	37	47	45
6	38	40	43	38	39	48
7	39	40	45	37	39	41
8	39	37	35	37	45	43
9	39	37	43	38	41	40
10	41	36	47	37	40	45

SUBJECT #18

Forward

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	32	68	30	54	35	56
2	39	58	31	55	31	56
3	38	57	32	56	25	58
4	32	58	30	62	26	63
5	-	-	34	62	30	55
6	32	63	34	62	31	58
7	36	59	31	59	34	55
8	33	57	34	59	33	57
9	39	57	39	59	25	60
10	39	60	32	56	33	57

Left

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	37	40	30	41	32	44
2	31	40	32	40	33	48
3	31	40	34	38	29	45
4	32	37	31	36	26	46
5	31	40	31	37	30	47
6	37	35	35	37	32	45
7	34	41	38	37	35	45
8	32	40	34	36	28	45
9	32	41	42	41	31	45
10	34	41	31	38	-	-

Right

	5%		20%		35%	
Trial	RT	MT	RT	MT	RT	MT
1	35	42	37	41	38	51
2	36	47	38	41	34	48
3	40	46	33	39	38	47
4	35	43	33	40	40	44
5	33	42	38	39	33	47
6	46	39	38	37	34	45
7	38	43	36	37	37	43
8	34	43	36	38	40	43
9	35	41	42	43	39	43
10	36	43	38	38	34	38